THE ECONOMIC VALUE OF ALASKA'S COPPER RIVER PERSONAL-USE AND SUBSISTENCE FISHERIES: AN APPLICATION OF THE ZONAL TRAVEL COST MODEL

A

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ECONOMIC VALUE OF ALASKA'S COPPER RIVER PERSONAL-USE AND SUBSISTENCE FISHERIES USING THE ZONAL TRAVEL COST MODEL

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Abstract

The salmon harvest on the Copper River, Alaska, is shared by commercial, sport, personal-use and subsistence fishers. An important and reoccurring issue is the allocation of salmon harvest among these user groups. Economic analyses, along with biological, legal, social and cultural considerations, have the potential to help policy makers appreciate the consequences of alternative allocations. Although economic analyses of the commercial and sport fisheries have been completed, no comparable studies exist for the personal-use and subsistence fisheries. The zonal travel cost method (TCM) is used to estimate the net economic value (consumer surplus) of the Copper River Basin personal-use and subsistence fisheries. The nature of the fishery and the data set is especially well suited for this purpose.

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1. Introduction

The Copper River begins as a glacial stream in Alaska's Wrangell Mountain Range and gathers its strength from tributaries including the Slana, Gulkana, Klutina, Tonsina and Chitina rivers as it flows south into Prince William Sound. (See Figure A.1 in Appendix A for a map of the Copper River Basin.) With its plentiful wild game and fish stocks, the Copper River Basin has supported human populations for millennia. Although many changes have taken place, fish stocks remain important to the livelihood and lifestyle of many Alaskans.

The annual harvest of Copper River salmon averaged nearly 1.6 million fish between 1988 and 1996. This harvest is shared among commercial, sport, subsistence and personal-use fishers. Chinook (Oncorhynchus tshawytscha), sockeye (O. nerka), and coho (O. kisutch) salmon are the dominate species in the Copper River system.

In 1996, the commercial fishery was comprised of 505 limited entry permit holders who mainly fished off the river's mouth near Cordova. Commercial fishers harvested nearly 91% of the 1996 catch of Copper River origin salmon, concentrating their effort on sockeye and chinook in June and July (ADF&G 1996b).

The sport fishery focuses almost exclusively on chinook and takes place in June and July in the Copper River's clear-water tributaries, most notably the Gulkana and Klutina rivers. Approximately 30,000 anglers participated in the sport fishery during 1996 and harvested approximately 3% of the total salmon catch (ADF&G 1996b). The sport fishery is open to all resident and non-resident license holders, subject to season, geographic, gear and bag restrictions.

The personal-use and subsistence fisheries allow participants to harvest fish for personal consumption and traditional exchanges near Chitina, Alaska. These fisheries are open for seventeen weeks from June 1 to September 30. During the first twelve weeks of the season, sockeye comprise 97% of the harvest and chinook comprise the remaining 3%. During the last five weeks of the season, 63% of the harvest is sockeye salmon and 37% is coho salmon. Figure A.2 in Appendix A illustrates the weekly catch by species. Rules governing eligibility for participation in the personal-use and subsistence fisheries have evolved over time and can be expected to continue to evolve due, in part, to the expansion of Federal authority pursuant to the Ninth Circuit Court's decision in Katie John v. Alaska (Native American Rights Fund 1995), and the likely federal assumption of management authority under ANCSA (PL 92-203 1971).

Participation in the personal-use fishery is currently restricted to Alaska residents who have purchased a sport-fishing license ($15) and have paid the $10 annual access fee. The access fee is the result of an agreement between Ahtna and Chitina Native Corporations and the State which allows personal-use and subsistence fishers to trespass on native land holdings. The entire access fee is forwarded to the native corporations, the State of Alaska does not receive any of these funds.

Under current state law, all Alaska residents are eligible for subsistence permits with the same access fees as the personal-use permits. However, Federal regulations stipulate a zip code based eligibility system that excludes urban residents. The urban stipulation excludes people who live in the Anchorage-Matanuska, Fairbanks, Kenai Peninsula, and Juneau regions from participating in the subsistence fishery. The Alaska State legislature is currently revising subsistence eligibility to conform to Federal guidelines. Changes can be expected to affect the 1999 fishing season, whether the State relinquishes control to the Federal government or new State regulations are adopted.

The permits issued for personal-use and subsistence fishing can be categorized by fishing method and bag limits. There are personal-use family household permits, personal-use permits held by single member households, and subsistence permits. Neither of the fisheries are restricted to only one gear type, however the subsistence fishery is predominantly fished by fishwheels and the majority of personal-use fishers use dip nets[1].

While personal-use season bag-limits vary according to run-strength, single member households have usually been allocated a limit of 15 fish and family households have been allocated 30 fish with an increase of ten salmon for every member of the household if there are more than two people in the household. These bag limits include a maximum of five chinook salmon. Of the 7,000 personal-use permits issued in 1996, 14% were issued to single member households and 86% to family households. These participants harvested 4% of the total 1996 salmon harvest (ADF&G 1996b).

The subsistence fishery annual permit harvest limit is 30 fish for single member households and 60 for households of more than one with an increase of ten salmon for every member of the household if there are more than two people in the household. These bag limits include a maximum of five chinook. Subsistence permit holders may request bag limits up to 200 and 500 for individuals and families, respectively. Family households may be defined as an entire village or extended family. However, there is only one category of subsistence permits in the permit database because the Alaska Department of Fish and Game (ADF&G) does not differentiate between individual and family household subsistence permits. Subsistence fishers harvested 2% of the total 1996 salmon catch by fishing approximately 800 permits (ADF&G 1996b).

The Alaska Board of Fisheries is responsible for making fisheries management decisions. Allocation of catch among competing user-groups is among the most contentious and perennial management issues faced by the Board. In making allocation decisions, the

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[1] Fishwheels are apparatuses placed in the river along the bank. The current spins the wheel and fish are trapped as they swim up stream. A dip net is a rigid pole with a bag-shaped net (no more than five feet in diameter) attached to the end. Dip nets are used to fish from a river bank and, in some instances, from drifting boats.

Board is required to be consistent with three hierarchically ranked objectives. Foremost is the goal of ensuring that spawning escapements are sufficient to support maximum sustained yields. Returning salmon in excess of required spawning escapements are available for personal-use, subsistence, commercial, and sport fisheries. The State of Alaska has identified subsistence as the highest priority use. Commercial and sport fisheries are permitted when managers anticipate that escapement targets and subsistence needs will be satisfied. To date, salmon stocks have been sufficient to support all fisheries in the Copper River Basin.

Although there have been several thorough economic analyses of the commercial fishery. (Herrmann and Greenberg 1994 and Boyce, Herrmann, Bischak and Greenberg 1993), and the sport fishery (Layman, Boyce, and Criddle 1996), there are no comparable economic valuation studies of the personal-use and subsistence fisheries in the Copper River Basin. This research seeks to provide economic information regarding the personal-use and subsistence fisheries. This research estimates the consumer surplus per household permit holder for the personal-use and subsistence fisheries using the zonal travel cost method.

2. Methodology

Personal-use and subsistence fishing is a non-market activity that can not be valued by standard techniques that use market prices. Prices and quantities of market goods are determined by consumers' willingness to pay and producers' willingness to supply. For activities such as personal-use and subsistence fishing, there are no producers who must cover their costs, consequently, the consumer does not have to pay the price he or she is willing to pay, hence economic value of non-market activities is not fully captured by participant expenditures. Economists have developed specialized techniques to estimate the economic value of these types of activities.

One such method is the travel cost method (TCM). the TCM has been used by economists to place an economic value on sport fishing and other recreational activities (Bockstael, Strand, McConnell and Arsanjani 1990, Calkins, Bishop and Bouwes 1986, Kealy an Bishop 1986, Donnelly, Loomis and Nelson 1985). The TCM relies on observed behavior to obtain estimates of economic value.

The implicit price participants are willing to pay to use a recreation site is a combination of the site user fee (if any) and the cost of traveling to the site. The travel cost includes the opportunity cost of time associated with traveling as well as the cost of distance traveled. The TCM is based on the recognition that the cost of traveling to a site is an important component of the decision to visit a site and, for any given site, there will usually be wide variation in travel cost across visitors to that site. It is also recognized that as the distance between an individual's residence and the site increases, the likelihood of that individual visiting the site decreases. If the length of time spent on site during each trip is constant, the site entrance fees are negligible, and any free time could be spent working at a predefined wage, then demand for site use can be readily measured by the number of trips to the site. Moreover, the implicit price of a trip becomes the sum of vehicle-related travel costs and the opportunity cost of travel time (Smith and Kaoru 1990).

This research makes use of the zonal TCM. The zonal TCM groups participants into zones that are different distances from the site. The TCM then estimates a relationship between the visitation rate (VR_i) from each zone and that zone's travel costs (TC_i). The zones are defined as areas in which residents face similar travel time and routes and have similar income and other demographics. Therefore, the visitation rate is modeled as

$$VR_i = f(TC_i, Y_i, D_i, Q_i, S_i) \tag{2.1}$$

where VR_i is the visitation rate defined as the number of visits from zone i to a recreation site divided by the population of zone i, TC_i is the travel cost (implicit price) to the site from zone i, Y_i is the median income of individuals from zone i, D_i is a vector of demographic characteristics of individuals from zone i, Q_i is a vector of quality characteristics (i.e. harvest and allocations) of the site, and S_i is the travel cost (implicit price) to substitute sites from zone i.

Equation (2.1) can be used to estimate points on a demand curve for each zone by incrementing TC_i until the estimated number of trips from zone i equals zero at the choke price (P_i^*). Thus establishing a derived demand curve for zone i. The derived demand curves for all zones are then aggregated to derive the site's demand curve.

An aggregate demand curve derived from (2.1) can be treated as a Marshallian demand in the travel cost (Smith 1988). This demand curve captures the total economic value participants place on the activity at the site. The area under the derived demand curve defines the consumer surplus associated with the use of a site. Consumer surplus (CS) is defined as the integral from P_i (actual travel cost paid) to P_i^* of the derived demand curve, $x_i(p)$.

$$CS_i = \int_{P_i}^{P_i^*} x_i(p)dp \tag{2.2}$$

Once the consumer surplus is known it is possible to compute the consumer surplus per participant or trip.

When the quality of an attribute at a recreation site changes, it is recognized that the change will most likely effect the visitation rate. If a visitation rate can be established before the change and after the change,two different aggregate demand curves can be established where the area between the two demand curves for the site is a measure of the welfare change, given the assumptions of weak complementarily (Freeman 1993). It is difficult to estimate how changes in site characteristics affect the value of the site to participants when site characteristics do not vary systematically during the study period.

Consequently, applications of the zonal TCM used to estimate the value of site characteristics or quality during one year rely on multi-site models.

This research will estimate the total consumer surplus derived from the use of personal-use and subsistence permits. The average consumer surplus per household permit will be computed by dividing the total consumer surplus by the number of household permits fished.

3. Data

3.1. Personal-Use and Subsistence Permits

Alaska Department of Fish and Game (ADF&G) maintains a time series-panel database constructed from personal-use and subsistence permits. This database includes records for each legal personal-use and subsistence fishing trip completed between 1988 and 1996 (nearly 90,000 records). Much of the information needed to implement the zonal TCM is available directly from this database. Table 3.1 lists the data recorded for each permit and Table 3.2 contains a descriptive summary of these variables.

Personal-use and subsistence fishers are required to record the date of their trip(s) as well as the number and type of fish caught on their permit. In addition to reported catch, each permit contains the city and zip codes of participants which can be used to track participation through time and place of residence. Permits are obtained in the cities of Chitina and Glennallen through personal registration. Participants are asked to leave their permit at the ADF&G office at the end of their fishing trip.

Table 3.1 ADF&G Permit Database Variables

VARIABLE	VARIABLE DESCRIPTION
PERMIT	number assigned to each permit by ADF&G
FWNUMB	number assigned to fishwheel apparatus by ADF&G
ALLOCATION	permit bag limit as recorded on permit
MONTH	month in which permit trip was taken
DAY	day of the month permit trip was taken
YEAR	1988-1996
ZIP CODE	permit holder's zip code
FAMILY SIZE	number of family members as recorded on permit
TRIP	permit trip number, i.e., first trip = 1, second trip = 2 *
SOCKEYE	total number of sockeye salmon caught during permit trip
COHO	total number of coho salmon caught during permit trip
CHINOOK	total number of chinook salmon caught during permit trip
STEELHEAD	total number of steelhead trout caught during permit trip
OTHER	total number of other fish species caught during permit trip (i.e. dolly varden and rainbow trout)
TOTFISH	total number of fish caught during permit trip

*Trip=5 incorporates all trips over 5 (i.e., fifth trip, sixth trip etc.)

Table 3.2 ADF&G Permit Database Variable Descriptive Statistics

VARIABLE	MEDIAN	MEAN	STD. DEV.	MINIMUM	MAXIMUM
Family size per permit	3	2.984	1.624	0	72
Number of trips per permit	1	1.5	0.869	1	5
Number of Sockeye per trip	6	11.756	17.446	0	493
Number of Coho per trip	0	0.465	1.281	0	85
Number of Chinook per trip	0	0.229	1.985	0	99
Number of Steelhead per trip	0	0.003	0.092	0	9
Number of other fish per trip	0	0.01	0.243	0	18
Total number of fish per trip	7	12.463	17.844	0	501

3.2. Zones

Participants in the Chitina personal-use and subsistence fishery travel from a wide range of locations within the State (See Figure A.3 in Appendix A). Participants have traveled one way distances ranging from 0.5 miles to 1,494 miles to fish the Copper River Basin. Individuals travel from communities such as Chitina, Glennallen and Anchorage in the South-central region and those who travel from communities on the Kenai Peninsula are from towns such as Homer, Seward, and Kenai. Participants also travel from communities within the Interior region which include Cantwell, Circle, Delta Junction, Eagle, Fairbanks, and Fort Yukon. Individuals even travel from the Southeast region of the State (i.e., Juneau, Ketchikan, Sitka, and Wrangell.) They also travel from as far away as Arctic region communities such as Kotzebue, Nome, Barrow, and Deadhorse. These communities vary not only in their distance from the personal-use and subsistence fisheries, but also in population, median income, and other demographics as displayed in Appendix B, Table B.1.

Implementing the zonal TCM requires communities to be organized into mutually exclusive zones. Because each zone is treated as a single observation in the *VR* equation (2.1), participants from the same zone should face similar travel costs and respond to changes in travel cost in the same manner. Zones also need to be constructed so that residents within a zone have similar income and tastes because the visitation rates are based on the assumption that participants who live in the same zone make similar travel decisions.

A list of all communities from which participants traveled to the Chitina fishery was constructed from the entire permit database (See Table B.2 in Appendix B). The most direct route to Chitina from each community was used to determine the distance traveled[2].

Communities listed in Table B.3 in Appendix B are part of the permit database, however, they were omitted in the zone construction due to their remote location. These

[2]The distance traveled from various Alaska communities to Chitina was collected from CyberRouter™, an Internet site.

communities, which make up 1% of the total number of trips, are not located near road systems providing access to Chitina. Due to the location of these communities, travel costs are different from road travel costs and most likely include air travel. It is also likely that the money and time spent flying out of these communities are part of multi-purpose trips and cannot be completely attributed to the personal-use and subsistence fisheries.

The 1990 Census Bureau provides median household income for 1990 by zip code. This income is reported as a before tax income, hence, all income was adjusted by average Alaskan tax liability by income bracket[3]. It is assumed that the income reported to the Census Bureau reflects an individual's perceived income. Individuals are not legally accountable for what they report on the Census, therefore, income reported is more likely to reflect an individuals true (perceived) income. The source of median household income for 1992–1995 was the IRS County–to–County Migration Flow Data. The IRS income is provided for borough and census areas. It is also assumed that the income reported to the IRS reflects what individuals legally report and therefore is less than what is reported for the Census. Available median household income data for Alaska is inconsistent through time and aggregation levels, hence, this research focuses only on the 1990 permit trip data. Another reason for focusing on 1990 is the fact that additional information is available at the zip code level of aggregation through the 1990 Census.

The zones were determined by the distance and travel route from the community to the fishery, and the community 1990 median household income. Communities within a single zone differ in distance from the personal-use and subsistence fisheries by no more than 40 miles, while the median incomes of the communities within a single zone differ at most by 14%. Anchorage and Fairbanks were divided into smaller areas based on zip codes in order to establish zones that are similar in median income. Table B.4 in

[3]Table 2 - Individual Income and Tax Data by State and Size of Adjusted Gross Income Tax Year 1995. Internal Revenue Service, Statistics of Income Bulletin, Spring 1997.

Appendix B displays the zip codes that were identified for different zones. Seventy-five zones have been constructed based on the entire permit database, these zones are listed in Table B.5 in Appendix B.

4. Model

4.1. Variable Construction

4.1.1. Visitation Rate

Although the permit database provides much of the data needed to implement the zonal TCM, additional variables are needed to compute the visitation rate (*VR*) and the travel cost (*TC*). Recall Equation (2.1).

$$VR_i = f(TC_i, Y_i, D_i, Q_i, S_i) \tag{2.1}$$

where

$$VR_i = \frac{\text{number of permit trips from zone } i}{\text{total number of households in zone } i} \tag{4.1}$$

and

$$\text{TC}_i = (\text{travel distance cost from zone } i) + (\text{travel time cost from zone } i) + (\text{site fee}) \tag{4.2}$$

The number of trips from zone i is the sum of the number of trips from each community within zone i and the total number of households in zone i is the sum of the number of households in each community within zone i. The components of TC_i are distance cost, which is the product of distance traveled and cost per mile, travel time cost, which is the product of time spent traveling and the shadow price of time, and the site fee per trip. The median household income of each community is used to approximate the wage rate, which is used to establish the shadow price of time.

The Census Bureau's 1990 Census database provided populations as well as the number of single member households and family households by zip code. We chose to define visitation rates by households because the permits are issued on a household basis and the database does not provide the number of individuals who fished the permit per trip. We assume that household trips to fish the Copper River are single purposed and only one permit is fished for each trip to Chitina. Although it is unlikely that two permits are fished per trip, it is recognized that, on average, more than one permit is fished per trip (i.e. some participants carpool). We also assume that each date recorded on the permit is a separate trip. It is possible that some trips may have been weekend trips for which each day's catch was recorded daily, therefore each date recorded is not necessarily a separate trip. This assumption leads to an overstated visitation rate.

4.1.2. Travel Costs

The travel distance cost is computed as

$$\text{travel distance cost} = (rtd_i)\,(cpm) \tag{4.3}$$

where rtd_i is the round trip distance from zone i to Chitina and *cpm* is the cost per mile.

We use three different values for *cpm*. One could argue that the cost of operating a vehicle should include vehicle wear and tear (i.e., oil, tires, etc.) as well as the cost of gasoline. However, individuals may make vehicle travel cost decisions based on the cost of gasoline only. The average miles per gallon for new vans, medium cares, large cars, sport utility vehicles and trucks in 1990 was 18 mpg according to Consumer Reports. The average wholesale price of gasoline in Alaska during 1990 was $1.12[4] per gallon. However, this price does not include the Alaska fuel tax. The 1990 fuel tax paid was $0.08[5], therefore the computed gasoline *cpm* for 1990 is $0.07. The State of Alaska

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[4]Energy Information Administration EI-782A & B as reported by Aileen Bohn from Department of Energy.

[5] Federal Tax Administration Motor Fuel Excise Tax Rates.

reimburses its employees \$0.31 per mile for use of personal vehicles for State business[6]. Because \$0.31 and \$0.07 are probably maximum and minimum values for *cpm*, an average value of \$0.19 is also used.

Equation 4.4 is the component of *TC* related to travel time.

$$\text{travel time cost} = (rtt_i)(k)(w_i) \tag{4.4}$$

where rtt_i is the round trip time from zone i to Chitina, k is the percent of the wage rate used to establish the shadow price of time, and w_i is the average wage rate of residents in zone i.

The time spent traveling from various Alaskan communities to Chitina was also collected from CyberRouter™. The time spent traveling was estimated using the maximum posted speed limit.

The assumption of one permit per trip understates the travel time cost per trip and ignoring time cost completely has the effect of biasing the elasticity estimates upward and the benefit estimated downward (Freeman 1993). Early studies recognize that the time spent traveling to a site should be included as a component of travel cost for purposes of estimating the demand for visits (Cesario and Knetsch 1970, Scott 1965 and Knetsch 1963). The choice of the shadow price of time is critical to the estimation of the elasticity of demand for the site and calculation of the value of the site. Choosing a high shadow price of time increases the importance of time cost in explaining visits as a function of distance. With a higher shadow price of time, the predicted reduction in the number of visits is smaller, and the estimated demand curve is less elastic.

On the assumption that individuals are free to choose the number of hours worked at a given wage rate, the time cost is valued at the wage rate. However, the appropriate

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[6] Mike Gavin of Alaska Department of Transportation, personal communication

shadow price of time depends on the alternative uses to which the time could be put and on the nature of the constraints on individual choice (Shaw 1992). Cesario and Knetsch (1970) maintain that the opportunity cost of time falls between 25% and 50% of the wage rate. Cesario (1976) concluded that the scarcity value of time was approximately 1/3 of the average wage rate. McConnell and Strand (1981) found 0.6 of the wage rate provided the best fit. The range for wage rate adjustment is generally suggested to be between 0.25 and 0.50 of the wage rate with the usual value adopted as 0.33 (Smith and Kaoru 1990). This research uses 0%, 30%, 60%, and 100% of the wage rate to value the opportunity cost of time because these values definitely cover the range of possible values for the opportunity cost of travel time. These values also allow comparisons with the Copper River sport fishery study by Layman, Boyce and Criddle (1996).

Hourly wage rate data is unavailable over the time period covered by the permit database so median income was used to compute a proxy for wage rate (w_i).

$$w_i = \frac{\text{household median income of residents in zone } i}{2000} \tag{4.5}$$

where household median income of residents in zone i is the weighted average of the community household median income within zone i. Dividing by 2000 is the standard conversion of annual median income to wage rate. It is assumed that median household income adequately reflects actual income of personal-use and subsistence permit holders.

4.1.3. Site Fee

As stated previously, an individual must pay a $10 access fee to obtain a personal-use or subsistence permit. The $10 access fee was converted into a per trip cost to include with the distance travel cost per trip and time travel cost per trip. Equation 4.6 illustrates the conversion.

$$\frac{(\#\text{of permits fished in zone } i)(\text{site fee})}{(\#\text{of trips from zone } i)} \tag{4.6}$$

It is also assumed that time spent fishing does not vary between permit users and that opportunity cost of time, while fishing, is zero. Hence, *TC* is the sum of the permit holder's cost of distance traveled to fish the permit per trip, the permit holder's cost of time to travel to the fishing site per trip and the cost of the site fee per trip.

4.1.4. Substitute Sites

If the travel costs of the relevant substitute sites are omitted from the estimated equation, its parameters will be biased and failure to consider substitutes increases the value of consumer surplus per visit estimates (Smith and Kaoru 1990).

Although there are many personal-use fisheries in Alaska, few are close substitutes for the personal-use and subsistence fisheries on the Copper River. For example, the Naknek River personal-use sockeye salmon fishery is a dip net fishery , located in Bristol Bay, which is not on a road system accessible to the entire state and the season ends on July 25. Another personal-use fishery is located on the Skewentna River. Here, the fish wheel is the only gear permitted, and the season is limited to July 15-31, 4am to 8pm. The Southeastern Alaska Area personal-use fishery located near Juneau is not road accessible to most of the State and the bag limit is restricted to 2 chinook, 6 coho, and 5 sockeye which can only be caught during July. The only personal-use fishery that may be considered a reasonable substitute for the Copper River personal-use fishery in Chitina is the Upper Cook Inlet Personal-use Salmon Fishery located near Kenai, Alaska. This site is a road accessible dip net fishery with bag limits similar to the Chitina fisheries, open from July 10 to August 5.

The travel cost to the Kenai River (*KTC*), the substitute site, was computed similar to *TC*. *KTC* is the sum of travel distance cost from zone i to Kenai and travel time cost from zone i to Kenai. The travel distance cost and the travel time cost are computed as

$$\text{travel distance cost from zone } i \text{ to Kenai} = (krtd_i)(cpm) \tag{4.7}$$

and

$$\text{travel time cost from zone } i \text{ to Kenai} = (krtt_i)(k)(w_i) \tag{4.8}$$

where $krtd_i$ is the round trip distance from zone i to Kenai and $krtt_i$ is the round trip time from zone i to Kenai, and w_i is the average household wage rate of residents in zone i.

4.1.5. Demographic Variables

By collecting additional explanatory variables, the variance in the regression errors can be reduced, and the resulting *CS* estimates more robust (Bockstael and Strand 1987). To explain visitation rates to the Chitina fishery, the following demographic characteristics are included: the number of males per zone, the number of Alaskan Natives per zone, and the median age per zone. Each of these variables were obtained from the *Alaska Population Overview 1996 Estimates* published by Alaska Department of Labor (DOL). The number of males and the number of Alaskan Natives in each zone were converted to percentages by dividing by the borough/census area population.

Unemployment rates and the percentage of residents receiving public assistance within the communities of each zone may also provide additional explanation for differences in visitation rates. Due to the federal guidelines for subsistence, rural designation is of primary importance to the fishery and is also included as an explanatory variable. Annual unemployment rates, the percentage of communities with rural designation and the percent of community residents receiving public assistance were obtained at the zip code level from the 1990 Census.

In order to identify influences of permit type composition (i.e., personal-use and subsistence) across zones on visitation rate, a variable representing the percentage of subsistence trips (*SUB*) for each zone was established from the database.

4.2. Functional Form

Past literature has tended to use linear, semilog and double-log specifications for the zonal TCM (Strong 1983, Ziemer, Musser and Hill 1980, and Rao and Miller 1971). However, there are no unambiguous answers for travel cost demand models. Most past research (Adamowicz, Fletcher, and Graham-Tomasi 1989, Bishop et al. 1988, McCollum 1986, Donnelly et al. 1985, McConnell 1985, Strong 1983, Vaughan and Russell 1982, and Smith 1975) has specified semilog models when implementing TCM. This research tests linear and semi-log model specifications.

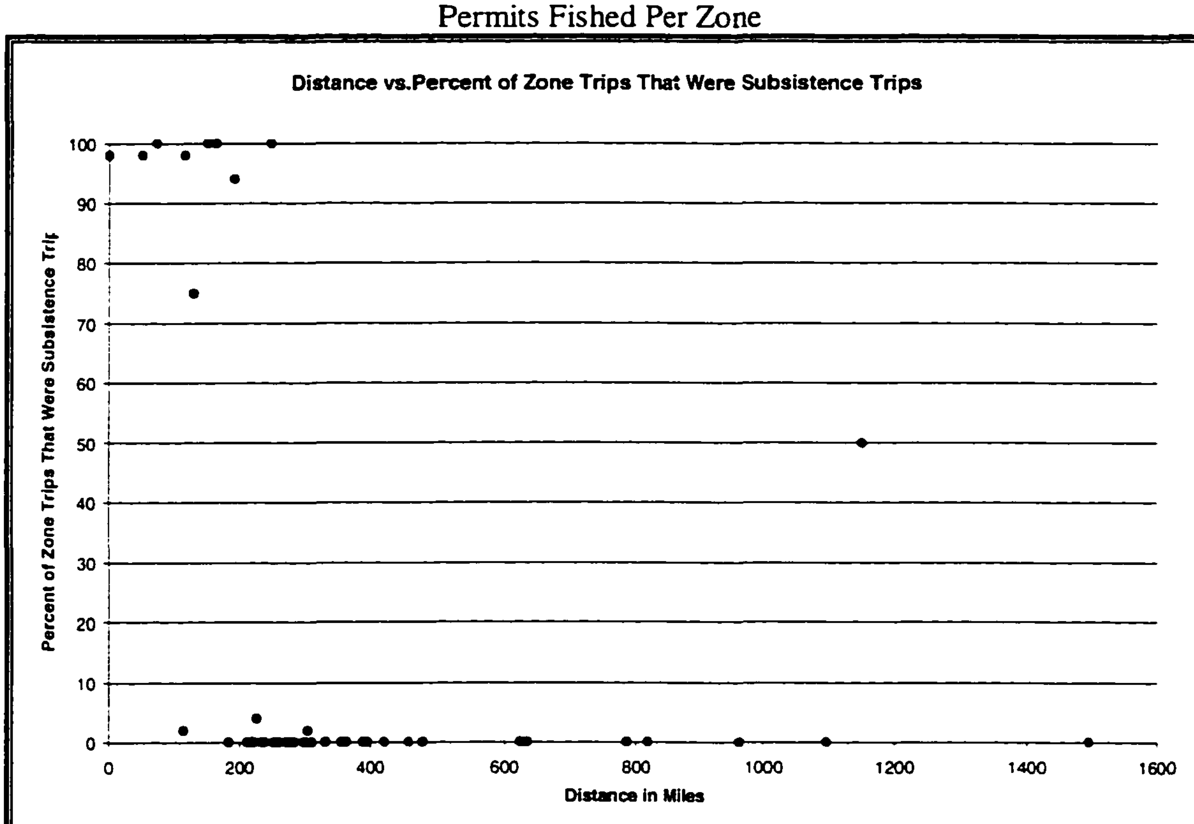
5. Results

5.1. Summary of 1990 Personal-use and Subsistence Fisheries

During the process of defining the model many scenarios were hypothesized which led to incidental information about the 1990 personal-use and subsistence permit holders. It was hypothesized that visitation rates may differ between the different types of permits. This led to the discovery that four zones, Gakona, Mentasa, Chickaloon and Northway, were zones in which subsistence permits were the only permits fished, and communities such as Sutton, Delta Junction, Houston, Wasilla, Anchorage, Talkeetna, North Pole, Chicken, Healy, Anderson, Nenana, Seward, and the Kenai Peninsula fished personal-use permits only. In addition, the number of subsistence permits fished per zone increases as the distance to the fisheries decreases (See Figure 5.1). There are ten zones that are less than 200 miles from Chitina and these zones account for 91% of all subsistence trips taken in 1990. In seven of these ten zones, more than 90% of all trips taken from each zone are subsistence trips.

The bag limits for the subsistence permit are larger than the bag limits for the personal-use permit, which may lead to different values for personal-use and subsistence permits. The zonal TCM presents difficulties for testing this hypothesis because of the aggregation of the data. Variation in individual bag limits would be lost in zone aggregation. It is also impossible, with the current database, to establish the population of possible participants (i.e., how many individual households per zone, and the number of individuals in households of more than one per zone) to establish visitation rates. Another issue with the bag limits is that once an individual has caught the permit limit, no (legal) additional trips may be made. Again, due to the aggregate data, the effects of bag limits on visitation rates is not estimable.

Figure 5.1 Relationship of Distance from the Fisheries to the Percent of Subsistence Permits Fished Per Zone



Another possible source for different demand curves arises from the varying composition of salmon caught throughout the season. As stated earlier, the first 12 weeks of the fisheries are characterized by a predominate sockeye run with some chinook, and the last five weeks of the season consists of a strong coho run accompanied by sockeye. In developing a model that would describe the differences in visitation rates between early and late seasons it was discovered that some zones were fished only by personal-use permit holders or only by subsistence permit. It was hypothesized that increases in salmon caught per permit in the early season would decrease the visitation rate in the late season due to the bag limit. However, due to the dependence of the late season visitation rate on early season participation and the aggregate zonal data, the models necessary to estimate this relationship are complex and beyond the scope of this research.

5.2. Visitation Rate Estimation

5.2.1. Linear Model

An Ordinary Least Squares (OLS) regression was run on 47 observations (28 of the 75 zones did not participate in the Chitina fisheries in 1990) using the variables defined in Table 5.1 to estimate Equation 5.1.

$$\begin{aligned} VR_i = {} & \beta_0 + \beta_1 TC_i + \beta_2 KTC_i + \beta_3 RURAL_i + \beta_4 PA_i \\ & + \beta_5 UNEM_i + \beta_6 NATIVE_i + \beta_7 GENDER_i + \beta_8 AGE_i \\ & + \beta_9 SUB_i + \varepsilon_i \end{aligned} \tag{5.1}$$

Where the subscript i indicates the zone for which each independent variable is an average of each community within the zone, weighted by the number of households in the community, with the exception of *SUB*. The variables *TC* and *KTC* are the result of valuing travel time at 30% of the wage rate and *cpm* at \$0.19 because this specification of travel costs is the most likely based on past literature.

Table 5.1 Regression Variables

REGRESSION VARIABLE	DESCRIPTION OF REGRESSION VARIABLES
VR_i	number of trips from $zone_i$ divided by total number of households in $zone_i$
$lnVR_i$	natural log of VR_i
TC_i	travel cost incurred during travel to the Copper River from $zone_i$
KTC_i	travel cost incurred during travel to the Kenai River (substitute site) from $zone_i$
$RURAL_i$	average percent of $zone_i$ categorized as rural
PA_i	average percent of population who receive public assistance, in $zone_i$
$UNEM_i$	average annual unemployment rate in $zone_i$
$NATIVE_i$	average percent of population whose race is Alaskan Native in $zone_i$
$GENDER_i$	average percent of population who are male in $zone_i$
AGE_i	median age of population in $zone_i$
SUB_i	percent of subsistence permit trips taken in $zone_i$
ε_i	error term

The linear model produced coefficients on the travel cost and substitute travel cost with the correct sign and with significance at the 90% confidence level. The intercept and SUB were also significant at the 90% confidence level (See Table 5.2).

However, there was evidence of heteroskedasticity for which the Goldfeld-Quandt test for heteroskedasticity was used. The sum of squared errors from an OLS regression run on zones with less than 400 households was compared to the sum of squared errors from an OLS regression run on zones with more than 1000 households, deleting zones with between 400 and 1000 households (20% of the observations). The F statistic, 308.15, was greater than the critical $F_{(10,10)}$=2.978, therefore the null hypothesis of homoskedasticity was rejected at the 95% confidence level. Heteroskedasticity due to number of households was corrected by weighting each variable by the reciprocal of the square root of the total number of households in each zone.

Table 5.2 Linear Models

Variable	OLS Linear Model	WLS Linear Model
Intercept	4.554**	0.127
	(1.748)	(0.131)
TC	-0.002**	-0.0004
	(-1.964)	(-1.143)
KTC	0.002**	0.0002
	(1.714)	(0.784)
PA	-1.986	-0.443
	(-1.128)	(-0.744)
RURAL	0.203	-0.002
	(0.746)	(-0.034)
UNEM	-0.485	0.058
	(-0.338)	(0.073)
AGE	-0.072	0.002
	(-1.211)	(0.107)
GENDER	-3.004	-0.137
	(-1.611)	(-0.191)
NATIVE	-1.214	0.053
	(-1.940)	(0.239)
SUB	0.006**	0.005*
	(1.765)	(2.589)
Adjusted R^2	0.273	0.1648
RMSE	0.662	6.739
N	47	47
df	37	37

*significant at the 95% confidence level ** significant at the 90% confidence level

Note: t-statistics reported in parenthesis

Even with this correction factor, the model still remained heteroskedastic (See Table 5.3) and only one independent variable was significant, SUB was significant at the 95 % confidence level (See Table 5.2). Specifying the regression model as semi-log reduces heteroskedasticity (Strong 1983) therefore another model (equation 5.2) was run using OLS.

Table 5.3 Test for Heteroskedasticity

	OLS	WLS
SSE for model with number of households<400	12.978	957.93
SSE for model with number of households>1000	0.043	308.148
F statistic	301.8	3.109
$F_{(10,10)}$	2.978	2.978
Conclusion	Reject H_0	Reject H_0

5.2.2. Semi-log Model

An OLS regression was run on the 47 observations using the variables defined in Table 5.1 and travel costs computed by using 30% of the wage rate to value opportunity cost of time and $0.19 for *cpm* to estimate Equation 5.2.

$$\begin{aligned}\ln VR_i = \beta_0 + \beta_1 TC_i + \beta_2 KTC_i + \beta_3 RURAL_i + \beta_4 PA_i \\ + \beta_5 UNEM_i + \beta_6 NATIVE_i + \beta_7 GENDER_i + \beta_8 AGE_i \\ + \beta_9 SUB_i + \mu_i\end{aligned} \tag{5.2}$$

Where the subscript i indicates the zone for which each independent variable is a weighted average with the exception of *SUB*.

The results of the OLS regression are shown in Table 5.4 with t-statistics reported in parentheses. The coefficients on *TC* and *KTC* are significant at the 95% level with the expected sign and *UNEM* was positive and significant at the 95% confidence. *PA*, the percent of residents receiving public assistance, was negative and significant at the 90% level.

RURAL and *SUB* were not significant nor were *NATIVE*, *GENDER*, or *AGE*. *NATIVE*, *GENDER* and *AGE* are available by borough/census area level only, hence, the insignificance of these coefficients in a model constructed from zip code level visitation rates is expected. Another Goldfeld-Quandt test was performed to investigate heteroskedasticity in the semi-log model. The null hypothesis of homoskedasticity could not be rejected, with the computed F statistic=0.880 and the critical $F_{(10,10)}$=2.978. Therefore, the transformation on *VR* (i.e., *lnVR*) eliminated the heteroskedasticity evident in the linear model.

Table 5.4 Semi-log Model Regression Output with Travel Cost Computed Using 30% of Wage Rate to Value Travel Time and $0.19 Per Mile to Value Travel Distance

	Full Model	Restricted Model		
INTERCEPT	-2.193	-3.804*		
	(-0.277)	(-5.242)		
TC	-0.008*	-0.011*		
	(-3.101)	(-3.202)		
KTC	0.005*	0.007*		
	(2.356)	(2.547)		
RURAL	0.568	0.374		
	(0.726)	(0.495)		
PA	-9.851**	-11.032*		
	(-1.922)	(-2.167)		
UNEM	9.154*	8.792*		
	(2.219)	(2.136)		
NATIVE	0.855	na		
	(0.460)			
MALE	-3.797	na		
	(-0.680)			
AGE	0.007	na		
	(0.040)			
SUB	0.010	0.012		
	(0.932)	(1.348)		
RMSE	1.927	1.921	*Partial F*	.871
R^2	.514	.478	$F_{(3,40)}$	2.839
Adjusted R^2	.3959	.400	Conclusion	cannot reject H_0
N	47	47		
df	37	37		

*significant at the 95% confidence level **significant at the 90% confidence level

A restricted model (Equation 5.3) was determined by using an F-test to eliminate insignificant borough/census area variables. However, RURAL and SUB were retained due to the importance of these variables to the personal-use and subsistence permitting system.

$$\ln VR_i = \beta_0 + \beta_1 TC_i + \beta_2 KTC_i + \beta_3 RURAL_i + \beta_4 PA_i + \beta_5 UNEM_i + \beta_6 SUB_i + \upsilon_i \tag{5.3}$$

Having established an acceptable model based on travel costs computed with $0.19 per mile and 30% of the wage rate for the opportunity cost of time, the restricted model was run using all combinations of *cpm* and *k* values. The *TC* and *KTC* variables were computed by varying cost per mile (*cpm*) and the percent of wage rate used to value the opportunity cost of travel time (*k*) resulting in the estimation of twelve different models.

The models are named in reference to the *cpm* value used (e.g., *LOWER* for $0.07 per mile, *AVG* for $0.19 per mile, and *UPPER* for $0.31 per mile) and in reference to the *k* value used (e.g., *0* for 0% of the wage rate, *30* for 30% of the wage rate, *60* for 60% of the wage rate and *100* for 100% of the wage rate). Table 5.5 lists the twelve model names and the travel costs associated with each model.

Table 5.5 Models Resulting from Varying Cost Per Mile (cpm) and Percent of Wage Rate (k) to Compute Travel Cost

MODEL	TRAVEL COST *cpm*	*k*	MEAN TRAVEL COST	STD. DEV.	MINIMUM	MAXIMUM
LOWER0	$0.07	0%	$58.88	$42.58	$4.83	$215.83
AVG0	$0.19	0%	$147.04	$114.72	$4.95	$574.39
UPPER0	$0.31	0%	$235.20	$186.89	$5.07	$932.95
LOWER30	$0.07	30%	$133.44	$110.81	$4.99	$515.74
AVG30	$0.19	30%	$221.60	$181.05	$5.11	$778.78
UPPER30	$0.31	30%	$309.76	$252.38	$5.23	$1,121.06
LOWER60	$0.07	60%	$208.00	$181.44	$5.15	$873.03
AVG60	$0.19	60%	$296.16	$250.15	$5.27	$1,136.07
UPPER60	$0.31	60%	$384.31	$320.38	$5.39	$1,399.11
LOWER100	$0.07	100%	$307.41	$276.19	$5.37	$1,349.43
AVG100	$0.19	100%	$395.57	$343.71	$5.49	$1,612.47
UPPER100	$0.31	100%	$483.72	$412.81	$5.61	$1,875.51

Table 5.6 displays the results of the OLS regressions for the twelve restricted models with the t-statistics reported in parentheses. *TC* was significant at the 95% confidence level with the expected sign in all models. The substitute price, *KTC*, was also significant at the 95% confidence level for models that included cost of travel time.

KTC was significant at the 90% confidence level for models in which cost of travel time was not included. *UNEM* was positive and significant at the 95% confidence level in all models. *PA* was significant at the 95% confidence level in all models except *LOWER100* and *LOWER60* for which the coefficients were significant at the 90% confidence level. *RURAL* still remained insignificant in all models while *SUB* was significant at the 90% confidence level in models that did not include opportunity cost of time.

Table 5.6 Restricted 1990 Model OLS Regression Output

Model	*UPPER100*	*AVG100*	*LOWER100*	*UPPER60*	*AVG60*	*LOWER60*
INTERCEPT	-3.859*	-3.897*	-4.022*	-3.840*	-3.824*	-3.911*
	(-5.535)	(-5.691)	(-5.980)	(-5.367)	(-5.465)	(-5.759)
TC	-0.005*	-0.007*	-0.008*	-0.006*	-0.009*	-0.013*
	(-3.394)	(-3.453)	(-3.35[illegible])	(-3.246)	(-3.417)	(-3.465)
KTC	0.003*	0.004*	0.005*	0.004*	0.006*	0.008*
	(2.758)	(2.811)	(2.682)	(2.603)	(2.777)	(2.804)
RURAL	0.437	0.513	0.651	0.384	0.437	0.593
	(0.591)	(0.702)	(0.894)	(0.510)	(0.592)	(0.818)
PA	-10.383*	-9.946*	-9.489**	-10.878*	-10.379*	-9.611**
	(-2.070)	(-1.991)	(-1.886)	(-2.145)	(-2.072)	(-1.925)
UNEM	9.065*	9.295*	9.737*	8.881*	9.019*	9.484*
	(2.246)	(2.321)	(2.428)	(2.168)	(2.237)	(2.337)
SUB	0.010	0.009	0.009	0.012	0.010	0.009
	(1.126)	(1.020)	(1.000)	(1.293)	(1.115)	(0.962)
Adjusted R^2	0.416	0.421	0.414	0.403	0.417	0.422
RMSE	1.895	1.887	1.899	1.915	1.893	1.884
N	47	47	47	47	47	47
df	40	40	40	40	40	40

Model	*UPPER30*	*AVG 30*	*LOWER 30*	*UPPER0*	*AVG 0*	*LOWER0*
INTERCEPT	-3.874*	-3.804*	-3.736*	-4.005*	-3.960*	-3.758*
	(-5.241)	(-5.242)	(-5.363)	(-5.157)	(-5.072)	(-4.690)
TC	-0.007*	-0.011*	-0.021*	-0.007*	-0.011*	-0.031*
	(-2.976)	(-3.202)	(-3.559)	(-2.477)	(-2.514)	(-2.677)
KTC	0.005*	0.007*	0.013*	0.004**	0.007**	0.021**
	(2.314)	(2.547)	(2.901)	(1.776)	(1.802)	(1.914)
RURAL	0.361	0.374	0.492	0.387	0.389	0.399
	(0.467)	(0.495)	(0.676)	(0.481)	(0.484)	(0.502)
PA	-11.412*	-11.033*	-10.009*	-12.010*	-11.989*	-11.891*
	(-2.205)	(-2.167)	(-2.017)	(-2.236)	(-2.237)	(-2.239)
UNEM	8.799*	8.792*	9.042*	8.897*	8.840*	8.585*
	(2.100)	(2.136)	(2.268)	(2.043)	(2.033)	(1.988)
SUB	0.014	0.012	0.009	0.018**	0.017**	0.017**
	(1.535)	(1.348)	(0.983)	(1.901)	(1.881)	(1.795)
Adjusted R^2	0.382	0.400	0.429	0.344	0.347	0.358
RMSE	1.949	1.921	1.874	2.008	2.004	1.986
N	47	47	47	47	47	47
df	40	40	40	40	40	40

* significant at the 95% confidence level   ** significant at the 90% confidence level

5.3. Consumer Surplus Estimates

The area under the demand curve is the measure of the value of the site. However, the demand curve is estimated from a statistical model in which random errors are associated with estimated parameters. This leads to random welfare measures. Smith (1990) has argued that when the purpose of statistical estimation of demand functions is derivation of welfare measures, estimators should be selected on the basis of statistical properties of the welfare estimates rather than statistical properties of the demand function parameters.

CS would reflect the average benefit per person if a per capita *TC* were established, however, the *TC* used in this research is a household permit trip cost. As a result, *CS* is the value of the use of household permits. Estimating different models for individual households and family households would have been more appropriate, however, the income data available does not provide income by family households and households of one. Hence, *CS* divided by total number of household permits will yield average benefit per household.

All twelve models were used to derive *CS* estimates because they span the range of likely parameter specifications.

$$CS = \sum_{i=1}^{75} \left[\frac{HH_i}{\hat{\beta}_1} \exp\left(\hat{\beta}_0 + \hat{\beta}_2(KTC_i) + \hat{\beta}_3(RURAL_i) + \hat{\beta}_4(PA_i) + \hat{\beta}_5(UNEM_i) + \hat{\beta}_6(SUB_i) \right) \times \left(\exp(\hat{\beta}_1)(P^*) - \exp(\hat{\beta}_1)(TC_i) \right) \right] \quad \textbf{(5.4)}$$

where HH_i is the total number of households in zone i and P^* is the estimated choke price of $3,000. Table 5.7 displays the estimated *CS* for each model.

Table 5.7 Consumer Surplus Estimates

MODEL	Total Consumer Surplus	Consumer Surplus Per Household Permit (5979)	Consumer Surplus Per Trip (8,456)
LOWER0	$90.734	$15.18	$10.73
AVG0	$252.265	$42.19	$29.83
UPPER0	$414.257	$69.29	$48.99
LOWER30	$146.366	$24.48	$17.31
AVG30	$281.400	$47.06	$33.28
UPPER30	$430.655	$72.03	$50.93
LOWER60	$228.617	$38.24	$27.04
AVG60	$345.577	$57.80	$40.87
UPPER60	$481.012	$80.45	$56.88
LOWER100	$345.824	$57.84	$40.90
AVG100	$447.537	$74.85	$52.93
UPPER100	$569.568	$95.26	$67.36

The total *CS* estimates range from $90.734 to $569,568 depending on values used for *cpm* and *k*. This value is in addition to the price (travel cost) individuals paid to participate in the fisheries. Dividing *CS* by the number of 1990 permits (5979) provides the average value of a personal-use/subsistence permit to a household. Values per permit for a household range from $15.18 to $95.26. The most likely value per permit is based on the opportunity cost of time valued at 30% of the wage rate. as supported by past literature. is between $24.48 and $72.03.

However. the reader is reminded that it was assumed that only one permit is fished per trip (i.e., no carpooling). As a result. the distance cost has been overestimated leading to understating the visitation rate and the consumer surplus associated with each trip. Also. it is possible that some weekend trips were recorded as two separate trips in the database. leading to overstating the visitation rate and the consumer surplus. It is unclear as to what the net affect of these assumptions is on the consumer surplus .

As mentioned earlier, consumer surplus estimates are random, therefore confidence intervals were established by using the simulation method suggested by Krinsky and Robb (1986). The simulation generates parameters with the same mean and variance as the estimated parameters. These generated parameters are then used to compute *CS*. The simulation performed for this research generated 2000 sets of parameters which led to 2000 *CS* estimates. These estimates provided 90% and 95% confidence intervals presented in Figure 5.1 and 5.2 and in Table 5.8.

At the simulated 95% confidence level, the lower bound of consumer surplus ranges from $56,00 to $390,00 and the upper bound ranges from $269,000 to $1,258,000 depending on the value for the opportunity cost of time and the cost per mile used. Based on the models incorporating 30% of the wage rate to value the opportunity cost of time, the most likely rage of consumer surplus at the estimated 95% confidence level is $184,000 to $684,000.

Table 5.8 K-R Simulation Consumer Surplus Confidence Interval Estimates

	K- R Median CS	90% CI lower bound	90% CI upper bound	95% CI lower bound	95% CI upper bound
LOWER0	$107.793	$65.062	$205.875	$56.087	$269.401
AVG0	$305.894	$182.567	$623.997	$157.546	$823.571
UPPER0	$505.249	$301.169	$1.010.827	$260.920	$1.356.573
LOWER30	$169.862	$109.733	$278.712	$96.248	$324.358
AVG 30	$339.939	$214.252	$574.509	$183.943	$683.845
UPPER30	$516.851	$326.686	$904.886	$286.553	$1.106.294
LOWER60	$270.507	$177.570	$443.713	$159.297	$516.817
AVG 60	$409.037	$267.162	$687..288	$235.279	$792.299
UPPER60	$578.426	$360.717	$974.763	$323.003	$1.170.749
LOWER100	$408.390	$261.554	$674.538	$231.554	$813.629
AVG 100	$530.986	$339.335	$863.002	$301.642	$999.471
UPPER 100	$666.942	$436.241	$1.077.735	$389.905	$1.257.741

Figure 5.2 Consumer Surplus 90% Confidence Intervals

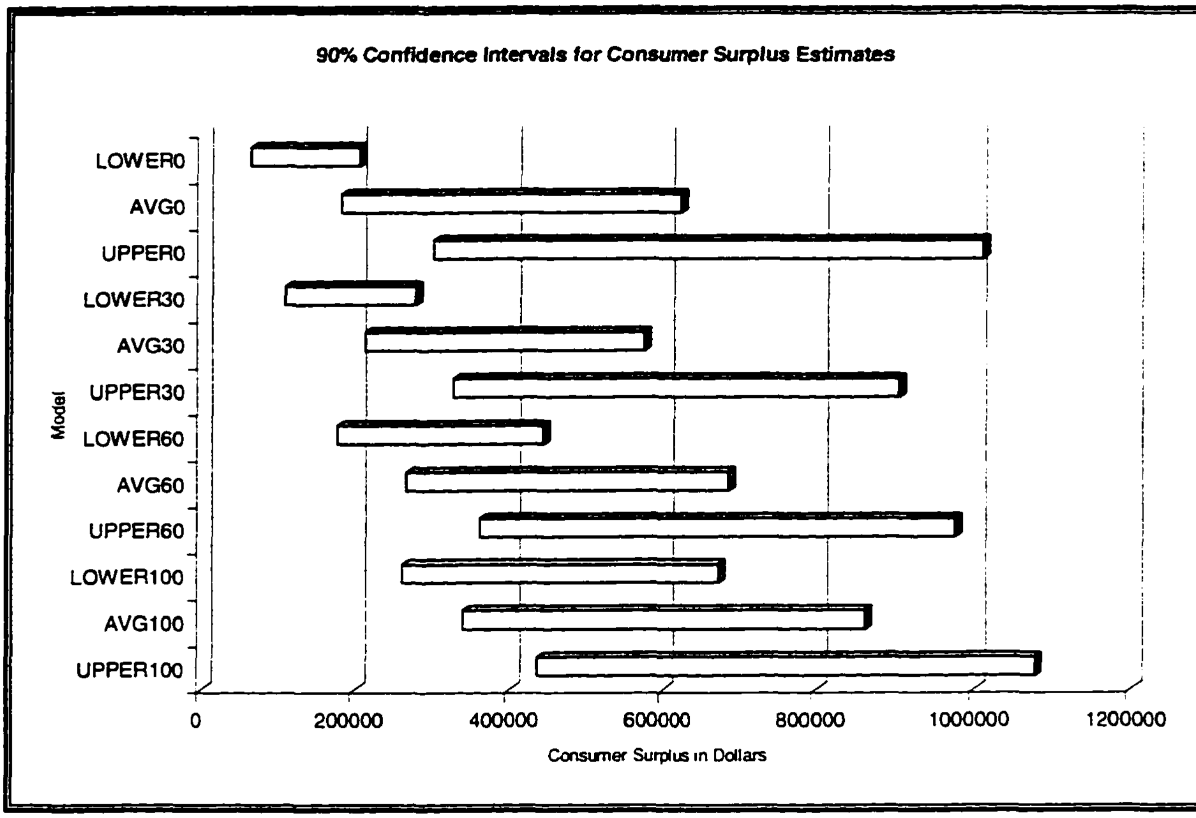
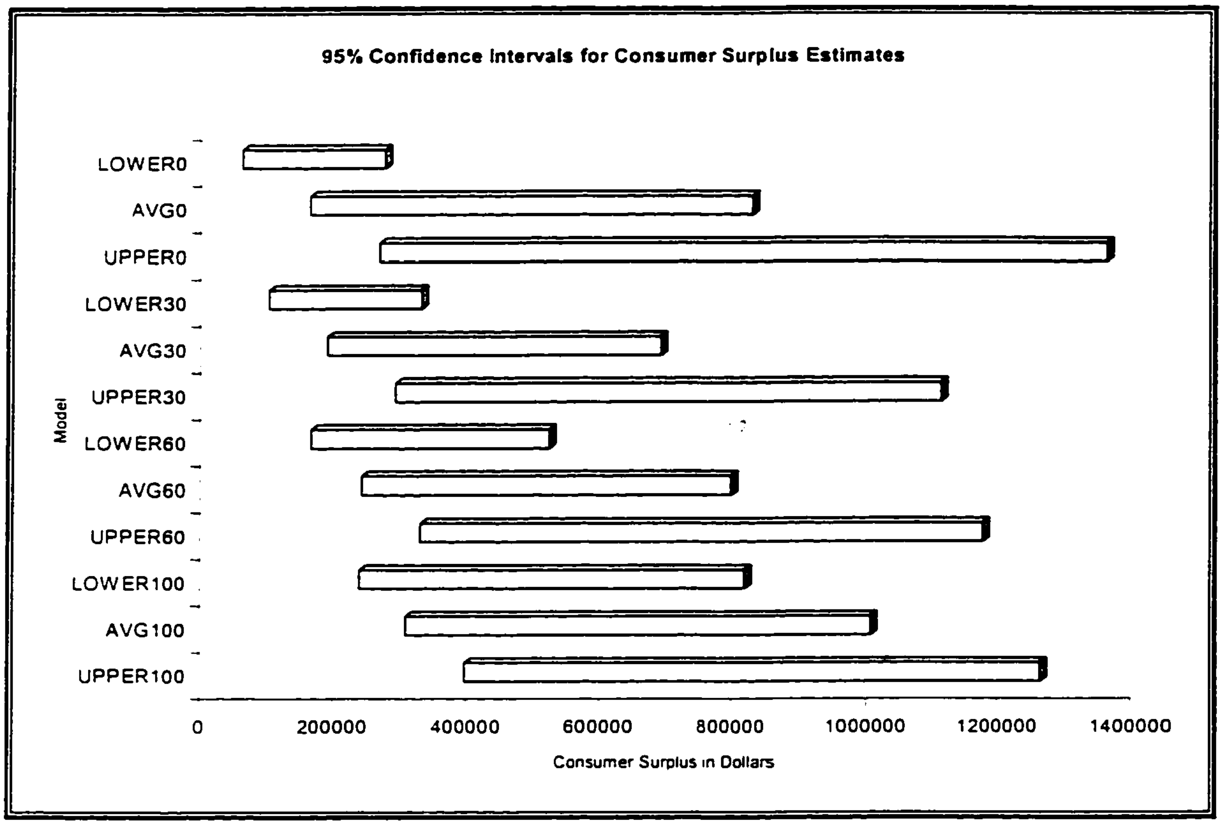


Figure 5.3 Consumer Surplus 95% Confidence Intervals



6. Conclusion

Nearly 6000 households participated in the personal-use and subsistence fisheries in 1990 harvesting approximately 6% of all salmon harvested in the Copper River Basin. This research applied the zonal travel cost method (TCM) to estimate the net economic value (consumer surplus) of personal-use and subsistence fisheries providing supplemental economic information about the Copper River Basin.

The most likely model, *AVG30*, is based on the value of travel time as 30% of the wage rate and the cost per mile as an average of the upper limit of $0.31 per mile and the lower of $0.07 per mile. The consumer surplus associated with this model is $281,400 with a simulated 95% confidence interval of $183,943 to $683,845. The average consumer surplus per household permit is equal to $47.06, with estimated consumer surplus per household permit between $30.76 and $114.37 at the simulated 95% confidence level. The other models incorporating 30% of the wage rate as the opportunity cost of travel time, *UPPER30* and *LOWER30*, generated average consumer surplus per household permit to be $72.03 and $24.48 respectively. The average consumer surplus per trip breaks down to $17.31 from *LOWER30*, $33.28 from *AVG30* and $50.93 from *UPPER30*.

Layman et al. report a consumer surplus per trip estimate for sport fishing on the Gulkana River in the Copper River of $26.05. This estimate is based on valuing the opportunity cost of time at 30% of the wage rate and using a cost per mile that incorporates vehicle operation costs (believed to be comparable to the upper limit of $0.31 per mile used in this research). A comparable value from the *UPPER30* model for personal-use and subsistence trips to the Copper River is $50.93 per trip. The value per trip in the personal-use and subsistence fisheries is nearly twice the value per sport fishing trip regardless of how opportunity cost of travel time was computed (e.g., 100%, 60%, 30 % or 0% of the wage rate).

It would be of interest to estimate separate values for the personal–use and subsistence fisheries. However, separate visitation rates are not possible since the population of households per zone that qualify for each of the fisheries is not known. Because the composition of the salmon differs throughout the season, separate visitation rate models for the early season (first 12 weeks) and late season (last 5 weeks) would also be interesting.

Based on existing studies, use of an average wage rate or income per hour to measure the opportunity cost of time would reduce consumer surplus per trip relative to its value with an individual specific wage estimate (Smith and Kaoru 1990). A survey instrument would allow a researcher to apply an individual travel cost model which would most likely provide consumer surplus estimates greater than consumer surplus estimated in this research. An on site survey could be implemented using a small sample to the database to represents the population of personal-use and subsistence permit holders.

An individual travel cost model may also allow a researcher to investigate bag limit issues as well as differences in personal-use and subsistence trips. The on site survey would need to provide information on individuals to provide the foundation for an individual travel cost model. Such information would include individual data on income, reasons for fishing personal-use permits instead of subsistence permits, or vis-a-vis. The survey instrument should also be designed to acquire specific information about tastes and preferences, reducing the need to rely on aggregated demographic variables. It should also include questions about services used when participating in the personal-use and subsistence fisheries (i.e., charter boats, lodging, etc) allowing for better travel cost estimates which would result in better visitation estimates. Survey information would also allow researchers to incorporate a time series analysis of the fisheries. The time series approach would allow participation rates to be tracked through time as a function of run strength and bag limits.

There is still much to be discovered from this ADF&G permit database with an appropriate survey based on a random sample of the population of personal-use and subsistence fishery participants.

7. Appendix A Figures and Maps

Figure A.1 Copper River Basin Map

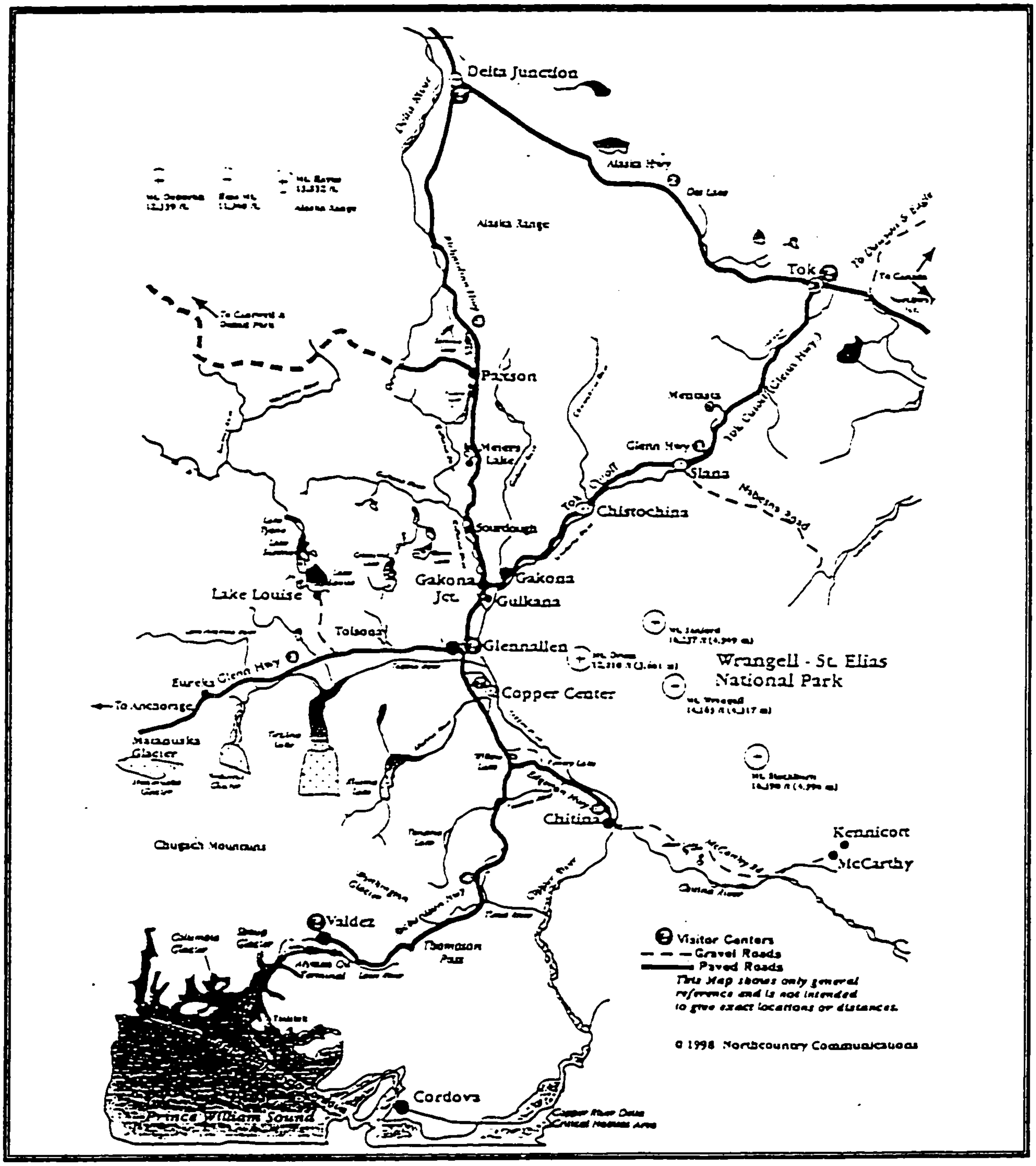
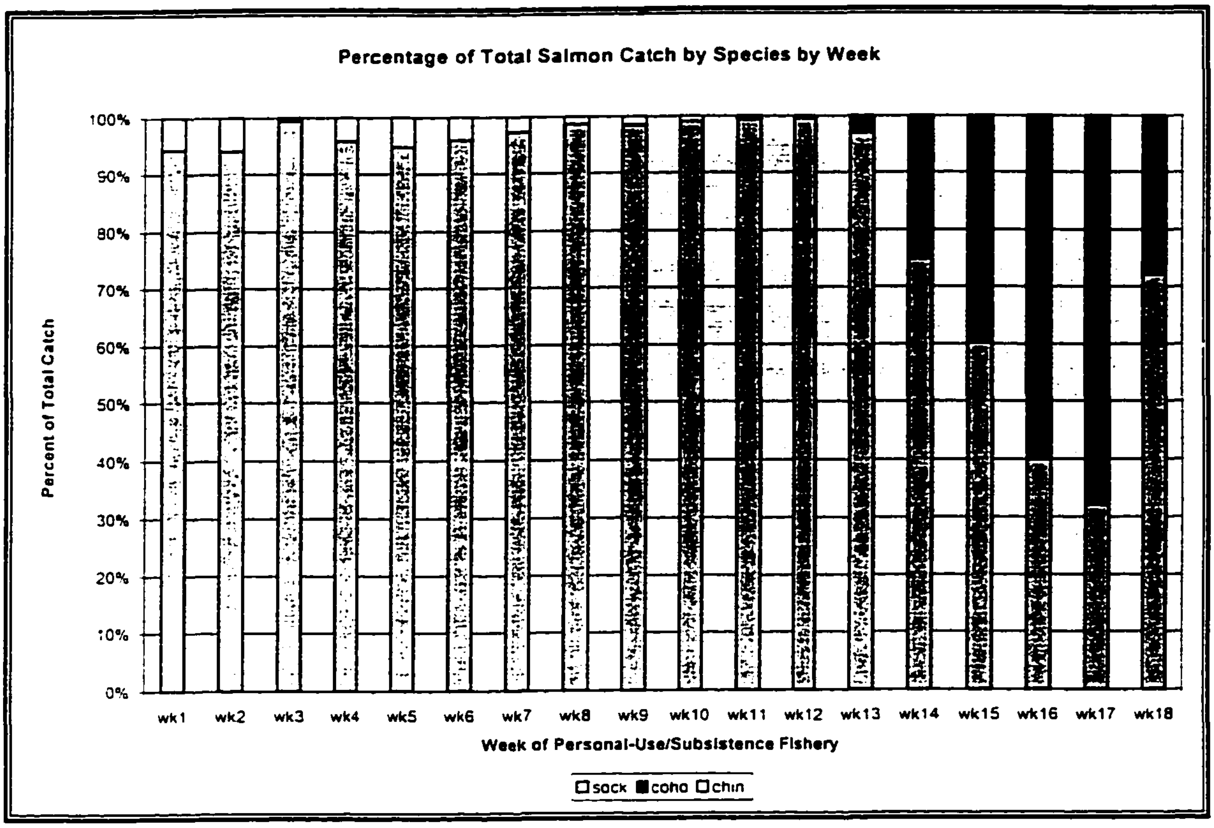


Figure A.2 Salmon Species Harvest by Week of Season



8. Appendix B Tables

Table B.1 Summary Statistics of Alaskan Communities

Variable	Mean	Std Dev	Minimum	Maximum
Distance to Chitina	380.63	306.18	.50	1,494.00
Travel Time to Chitina	10.70	10.91	.02	43.20
Median Household Income	25,045.26	3,944.87	16,733.97	35,413.07
Community Population	5,585.67	12,983.60	25	75,819
Total Number of Households	1,345.81	2,198.64	1	8,603
Summer Unemployment Rate	0.03	0.01	0	0.05
Annual Unemployment Rate	0.18	0.14	0	1
Median Age	29.87	1.66	26.4	34.20
Percent of Population that is Alaskan Native	0.16	0.19	0.05	0.73
Percent of Population that is Male	0.59	0.13	0.51	0.90
Percent of Population on Public Assistance	0.10	0.09	0.00	0.37

Table B.2 *List of Communities*

CITY	DISTANCE	TIME	CITY	DISTANCE	TIME
Anchor Point	409	9:40	Fairbanks11	303	7:17
Anchorage1	239	5:36	Fairbanks6	303	7:17
Anchorage15	239	5:36	Fairbanks7	303	7:17
Anchorage16	239	5:36	Fairbanks75	303	7:17
Anchorage17	239	5:36	Fairbanks9	303	7:17
Anchorage18	239	5:36	Fox	313	7:32
Anchorage2	239	5:36	Fritz Creek	397	9:20
Anchorage3	239	5:36	Ft Greely	222	5:30
Anchorage4	239	5:36	Ft Richardson	232	5:28
Anchorage7	239	5:36	Ft Wainwright	286	6:52
Anchorage8	239	5:36	Ft Yukon	395	9:34
Anderson	331	8:07	Gakona	73	1:49
Big Lake	221	5:15	Girdwood	274	6:24
Birch Creek	362	8:44	Glennallen	58	1:28
Cantwell	259	6:25	Gulkana	68	1:42
Central	480	11:41	Haines	624	15:20
Chickaloon	164	3:59	Healy	298	7:20
Chicken	272	6:38	Homer	397	9:20
Chistochina	102	2:31	Hoonah	819	1 1:52
Chitina	0.5	0:01	Hope	324	7:41
Chugiak	243	7:36	Houston	223	5:26
Circle	454	11:03	Hydaburg	1096	1 19:12
Clear	331	8:07	Indian	239	5:45
College	308.4	7:23	Juneau	786	23:09
Cooper Landing	365	8:36	Kasilof	399	9:25
Copper Center	44	1:07	Kenai	395	9:20
Cordova	203	8:39	Kenny Lake	25	0:30
Deadhorse	390	9:29	King Cove	1151	1 8:32
Delta Junction	213	4:48	Klawock	1089	1 18:59
Dot Lake	253	5:40	Kodiak	622	21:10
Douglas	787	23:11	Manley	460	11:12
Dutch Habor	1152	1 8:32	Mccarthy	65	1:50
Eagle	358	8:47	McKinley Park	279	6:53
Eagle River	224	5:18	Mentasta	150	3:42
Eielson AFB	280	6:44	Metlakatla	1387	1 17:43
Eklutna	211	5:06	Minto	428	10:26
Elmendorf AFB	238	4:36	Moose Creek	188	4:34
Ester	312	7:30	Moose Pass	334	7:51
Fairbanks1	303	7:17			

Table B.2 (cont.) List of Communities

CITY	DISTANCE	TIME	CITY	DISTANCE	TIME
Nebesna	219	5:17	Soldotna	383	9:02
Nenana	356	8:32	Steese	307	7:17
Nikiski	373	9:00	Sterling	371	8:43
Ninilchik	422	9:56	Sutton	180	4:22
North Pole	295	4:00	Talkeetna	278	6:48
Northway	248	6:01	Tanacross	205	4:58
Palmer	200	4:44	Tatitlek	123	3:21
Paxson	129	3:09	Tetlin	219	5:17
Petersburg	916	1 8:21	Tok	192	4:40
Port Graham	483	12:11	Unalaska	1494	1 7:35
Port Lions	648	23:09	Valdez	114	2:44
Salcha	263	6:20	Wasilla	252	6:07
Seward	364	8:34	Whittier	295	7:23
Sitka	933	1 8:54	Willow	211	4:00
Skwentna	280	6:47	Wiseman	350	8:25
Slana	131	3:12	Wrangell	963	1 11:30

Table B.3 *List of Excluded Communities*

Adak	Akiak	Alakanuk
Alexander	Ambler	Anaktuvuk Pass
Atqasuk	Barrow	Bethel
Bettles	Buckland	Dillingham
Emmonak	Galena	Gambell
Goodnews Bay	Grayling	Holy Cross
Hooper Bay	Kaktovik	Ketchikan
King Salmon	Kivalina	Kotzebue
Mcgrath	Mekoryuk	Naknek
Newtok	Nikolai	Nome
Noorvik	Pilot Station	Point Hope
Point Lay	Ruby	Scammon Bay
Selawik	Shishmaref	St. Paul
Stebbins	Tanana	Togiak
Trapper Creek	Tuluksak	Two Rivers
Unalakleet	Venetie	

Table B.4 *Anchorage and Fairbanks by Zip Code*

ANCHORAGE	ZIP CODE	FAIRBANKS	ZIP CODE
Anchorage1	99501	Fairbanks1	99701
Anchorage2	99502	Fairbanks6	99706
Anchorage3	99503	Fairbanks7	99707
Anchorage4	99504	Fairbanks9	99709
Anchorage7	99507	Fairbanks11	99711
Anchorage8	99508	Fairbanks75	99775
Anchorage15	99515		
Anchorage16	99516		
Anchorage17	99517		
Anchorage18	99518		

Table B.5 *Communities in 1990 Data Set by Zones*

COMMUNITY	ZONE	COMMUNITY	ZONE
CHITINA	A	NORTH POLE	Y
COPPER CENTER	B	SALCHA	Y
GLENNALLEN	B	CHICKEN	Z
GAKONA	C	MCKINLEY PARK	AA
CHISTOCHINA	D	HEALY	AB
SLANA	D	EIELSON AFB	AC
VALDEZ	E	FT WAINWRIGHT	AC
PAXSON	F	FAIRBANKS1	AD
MENTASTA	G	FAIRBANKS11	AD
MOOSE CREEK	H	FAIRBANKS6	AD
SUTTON	H	FAIRBANKS7	AD
CHICKALOON	I	FAIRBANKS75	AD
DELTA JUNCTION	J	STEESE	AD
DOT LAKE	K	FAIRBANKS9	AE
TOK	L	COLLEGE	AF
BIG LAKE	M	ESTER	AF
HOUSTON	M	ANDERSON	AG
WILLOW	M	CLEAR	AG
PALMER	N	NENANA	AH
WASILLA	N	SEWARD	AI
ANCHORAGE16	O	ANCHOR POINT	AJ
FT GREELY	P	HOMER	AJ
ANCHORAGE15	Q	SOLDOTNA	AJ
ANCHORAGE2	Q	FRITZ CREEK	AK
CHUGIAK	Q	KENAI	AK
EAGLE RIVER	Q	NIKISKI	AK
ANCHORAGE1	R	NINILCHIK	AL
ANCHORAGE3	R	CENTRAL	AM
ANCHORAGE8	R	MANLEY HOT SPRINGS	AN
ELMENDORF AFB	S	KODIAK	AO
FT RICHARDSON	S	PORT LIONS	AO
ANCHORAGE17	T	HAINES	AP
ANCHORAGE18	T	DOUGLAS	AQ
ANCHORAGE4	T	JUNEAU	AQ
ANCHORAGE7	T	HOONAH	AR
GIRDWOOD	U	HYDABURG	AT
INDIAN	U	DUTCH HABOR	AU
NORTHWAY	V	KING COVE	AU
CANTWELL	W	UNALASKA	AV
SKWENTNA	X		
TALKEETNA	X		

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IMAGE EVALUATION TEST TARGET (QA-3)

1.0 1.1 1.25 1.4 1.6 1.8 2.0 2.2 2.5 2.8 3.2 3.6 4.0 4.5 5.0

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6″

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